Missouri Department of Natural Resources
Water Pollution Control Program

Total Maximum Daily Load (TMDL)

for

Davis Creek
Lafayette County, Missouri

Completed December 26, 2000
Approved January 31, 2001

Revised June 17, 2003
(with additional changes July 15 and July 21, 2003)

Approved August 13, 2003

Phased Total Maximum Daily Load (TMDL)
For Davis Creek Low Dissolved Oxygen Impairment
Pollutants: Biochemical Oxygen Demand (BOD), Ammonia Nitrogen(NH_3-N)
And Nutrients

Name: Davis Creek

Location: Near the city of Odessa in Lafayette County, Missouri

Hydrologic Unit Code (HUC): 10300104-060001

Water Body Identification (WBID): 0912

Missouri Stream Class: The impaired segment of Davis Creek is a Class C stream[1]

Beneficial Uses: Livestock and Wildlife Watering, Protection of Warm Water Aquatic Life and Human Health--Fish Consumption

Size of Impaired Segment: 2 miles

Location of Impaired Segment: N 1/2 Section 9, Township 48 N, Range 27 W to SE 1/4 Section 10, Township 48 N, Range 27 W

Pollutants: BOD (Biochemical Oxygen Demand), Ammonia Nitrogen (NH_3-N) and Nutrients

Pollutant Source: Odessa Municipal Wastewater Treatment Facility—Southeast Lagoon and non-point sources exacerbated by lack of riparian canopy.

Permit Number: NPDES Permit No. MO-0026387

TMDL Priority Ranking: High

1. Background and Water Quality Problems

Davis Creek is on the 1998 303(d) list due to high BOD (which causes low dissolved oxygen) and high ammonia resulting from discharges from the Odessa Southeast Lagoon System. Missouri has proposed listing the waterbody on the 2002 303(d) list for nutrients. This TMDL is a revision of the TMDL approved by EPA on January 31, 2001. Since the approval of the 2001 Davis Creek TMDL additional data have been collected. Analyses of these data demonstrated that a significant water quality issue affecting the

[1] Class C streams may cease flow in dry periods but maintain permanent pools, which support aquatic life. See 10 CSR 20-7.031(1)(F)

overall health of the stream system has not been addressed. Although not identified on Missouri's EPA approved 1998 303(d) list, nutrient contributions are now known to play a significant role in the stream ecology than recognized in the original TMDL. The TMDL priority ranking for Davis Creek is high. During dry weather the stream flow in Davis Creek is effluent dominated. For this reason this TMDL was calculated at critical low flow conditions (7Q10).

The Odessa Southeast Lagoon System (OSLS) consists of a three cell lagoon with a facility design flow of 0.58 cubic feet per second (cfs). This translates to 375,000 gallons/day with a design population equivalent of 3,575. The facility discharges wastewater to a tributary to Davis Creek, and the outfall is located approximately 50 yards up the tributary from Davis Creek. Davis Creek then flows easterly through southern Lafayette County into the Blackwater River. The OSLS has been in noncompliance in the past. No monitoring records were sent in to Missouri Department of Natural Resources (MDNR) from December 1992 to May 1994. In 1997 the OSLS was cited for noncompliance due to exceedences in Total Suspended Solids (TSS) and BOD. As of the writing of this TMDL, however, the OSLS is in compliance.

At the request of the Water Pollution Control Program (WPCP), the Environmental Services Program (ESP) conducted two stream surveys of Davis Creek near Odessa, Missouri, in Lafayette County during July 15-17, 1997, and again July 8-9, 1998, as part of a wasteload allocation study. The purpose of the surveys was to quantify pollutant loading from the Odessa Southeast Lagoon System during minimal summer flows. Davis Creek at the point of discharge is a class C stream. There are no other point source discharges to Davis Creek above the impaired segment.

Land use within this area according to the Lafayette County Natural Resources Conservation Service (NRCS) is mostly row crop with some pasture and forested areas. In the six areas sampled during the 1997/1998 survey, the stream was moderately to mostly channelized, with partial to little tree canopy present. In two sample locations, erosion from livestock access and vehicle use was noted. Historically, the Davis Creek area was subject to infrequent flooding and riparian vegetation consisted of a mixture of native hardwood trees such as cottonwood, black walnut and white oak and native grasses. Currently, trees are found in scattered plots along the creek, and cultivated cropland accounts for much of the Davis Creek floodplain.[2]

Additionally, MDNR Planning Section staff collected data on August 14, 2002 and September 11, 2002 in connection with the Total Maximum Daily Load approved by the Environmental Protection Agency in 2001. During the course of the monitoring effort, the condition of the riparian corridor of Davis Creek was observed. It was noted that upstream from the OSLS outfall the dissolved oxygen measurement was less than 5.0 mg/L. Algae were present from the discharge pipe to the first downstream monitoring site. Algae past that point did not seem to be a problem. Water in the creek past the mixing zone was turbid but not green. Cattle impacts to the stream were observed at the

[2] Lafayette County Soil Survey, Soil Conservation Service, 1975, http://soils.missouri.edu/surveys/lafayette/gmapunit.htm#Blackoar

second sampling site, but were not evident upstream from the discharge pipe. Tree canopy was not improved since the previous studies in 1997 and 1998.

According to observations made by DNR staff during the August and September 2002 data collection trips, Davis Creek has an unusual flow regime. Davis Creek has stream segments that have decreasing, rather than increasing flow due to stream water flowing under the sand and gravel streambed, but not attributed to karst characteristics. Above the OSLS outfall, flow is intermittent with no flow during dry weather. Riparian (tree) canopy was lacking and high stream temperature and lowered dissolved oxygen could result from this degraded riparian condition. In the 1997/1998 as well as the August and September 2002 studies morning dissolved oxygen readings, whether above or below the OSLS outfall were less than 5.0 mg/L. According to data collected by MDNR, it is not unusual for Osage Plains region streams, of which Davis Creek is one, to naturally have dissolved oxygen levels of less than 5.0 mg/L.

Livestock access in Davis Creek was noted at station #4 in the 1997 and 1998 studies. Nonpoint source impacts were estimated and were not considered to be significant at the time the TMDL was written. Now, however, nonpoint source impacts are suspected to be more of a factor in the impairment to Davis Creek. A discussion of how the estimates were arrived at is located in Section #3, Load Allocation (Nonpoint Source Load).

Possible vehicle use in the stream was noted at station #5 in the 1997 study. The purpose for this traffic was unknown, but could be linked to moving cattle across the stream to other pastures, moving farming equipment between farm fields or recreational use.

As previously mentioned, water quality investigation of Davis Creek was conducted in both 1997 and 1998. Originally, this investigation concluded that the discharge from the OSLS was solely responsible for depressed levels of dissolved oxygen in Davis Creek and exceedence of State Water Quality Standards for ammonia. The OSLS did not have water quality based effluent limits for NH_3-N at that time. In the 1998 study, DO analysis results taken in the field included: 5.3 mg/L taken at 5:40 am; 5.2 mg/L taken at 6:07 am; 9.0 mg/L taken at 1:10 pm and 4.8 pm at 12:45 pm. The selection of pH 7.8 and the corresponding temperatures for the ammonia criteria were chosen to reflect typical seasonal conditions present (summer conditions). Subsequent to this study additional data has been collected that show that the role of non-point source and the ecological functions of the stream itself are contributing to the depression of DO. Elevated phosphorus and nitrogen in the system coupled with lack of riparian cover are leading to greater biological impacts in the stream (nuisance algae growth.)

The data in Appendix C show instances when dissolved oxygen levels in Davis Creek have fallen below the state standard of 5.0 mg/L. The low DO levels have been measured at the 7/8 and 9/98, 8/14/02, 9/11/02 studies, usually in the early mornings when dissolved oxygen levels in streams are lowest due to utilization during the night by living organisms. Readings of 2.0 and 4.0 mg/L DO were recorded on South Davis Creek (a nearby stream without point sources used for comparison) and in upper Davis Creek above the Odessa outfall.

During dry weather conditions there is no flow in Davis Creek above the Odessa Southeast Lagoons and the 7Q10 is considered zero. The July 15-17, 1997, survey reports that "The OSLS effluent discharge was the only noted source of flow into Davis Creek."[3]

Description of the Applicable Water Quality Standards and Numeric Water Quality Targets

Designated Uses

The designated uses of Davis Creek, WBID 0912, are Livestock and Wildlife Watering and "Limited" Warm Water Fishery. The stream classifications and designated uses may be found at 10 CSR 20-7.031(1) C and table H.

Anti-degradation Policy

Missouri's Water Quality Standards include the EPA "three-tiered" approach to anti-degradation, and may be found at 10 CSR 20-7.031(2).

Tier I defines baseline conditions for all waters—it requires that existing beneficial uses are protected. TMDLs would normally be based on this tier, assuring that numeric criteria (such as dissolved oxygen, ammonia) are met to protect uses.

Tier II requires no degradation of high-quality waters, unless limited lowering of quality is shown to be necessary for "economic and social development." A clear implementation policy for this tier has not been developed, although if sufficient data on high-quality waters are available. TMDLs could be based on maintaining existing conditions, rather than the minimal Tier I criteria.

Tier III (the most stringent tier) applies to waters designated in the water quality standards as outstanding state and national resource waters; Tier III requires no degradation under any conditions. Management may require no discharge or prohibition of certain polluting activities. TMDLs would need to assure no measurable increase in pollutant loading.

These TMDLs will result in the protection of existing beneficial uses, which conform to Missouri's Tier I anti-degradation policy.

[3] Stream Survey Sampling Report, Odessa SE Lagoon System and Davis Creek Survey, Missouri Department of Natural Resources, July 15-17, 1997, Page 5

Specific Criteria

Ammonia

The specific criteria, found in Missouri's Water Quality Standards at 10 CSR 20-7.031(4), apply to all classified waters. The specific criteria for the ammonia TMDL are found in 10 CSR 20-7.031 Table B. These limits are pH and water temperature dependent. Seasonal ammonia limits at the typical seasonal pH and water temperature values are given in the table found in **4. Waste Load Allocation (Point Source Loads); Summary of Loads.**

BOD_5

Dissolved oxygen (DO), is the water quality standard that is exceeded in Davis Creek. DO is not a pollutant and cannot be allocated in a TMDL. The determination of in-stream DO is a function of the physical, chemical, and biological processes. Demands for oxygen arise from the decomposition of organic matter either introduced to or generated within the stream and from chemical loads introduced to the stream. Oxygen can be restored to the system through photosynthesis by plants and reaeration of the stream. Photosynthesis and reaeration rates depend on sunlight and temperature and these parameters must be also considered when evaluating the aquatic community. Evaluation of in-stream DO is therefore a complex problem when all the processes are in play. The issue is further complicated because of the interrelationships between non-point sources, point sources, and stream characteristics.

Because wastewater contribution is a major source, a first step in rectifying the in-stream impairment is to establish limits on the discharge. BOD_5 is the parameter used to determine the impact that wastewater will cause on DO levels in a receiving stream. There is no numeric criterion in the water quality standards for BOD_5. Since DO cannot be allocated to the discharger, DO is linked to BOD_5. BOD_5 is a pollutant that is measurable and may be allocated in a TMDL. BOD_5 is composed of CBOD (carbonaceous oxygen demand) and NBOD (nitrogenous oxygen demand). NBOD can be estimated directly from ammonia nitrogen (NH3-N). The numeric link between dissolved oxygen and BOD is generated by the water quality model QUAL2E, and is supported by EPA. The QUAL2E model calculates BOD_5 by using CBOD and ammonia data from actual sample analyses. The OSLS upgrade includes converting to a mechanical treatment plant. Calibration for the QUAL2E model for the existing conditions, however, is based on the current lagoon system. Waste characteristics of a mechanical plant are dramatically different than a lagoon system. The use of the in-stream data collection can therefore help guide the decision about a wasteload for the upgraded facility. A verified model, however, will have to wait until the upgrade is completed and other measures must be considered to ensure that the State Water Quality Standards for dissolved oxygen[4] is achieved.[5] Limiting discharges from the facility in and of itself may not be sufficient to ensure that the DO standard is met because of the

[4] 10 CSR 20-7.031(4)(J)
[5] 10 CSR 20-7.031(4)(A)(3)

effects of in-stream photosynthesis, which depends on nutrient loads, and physical characteristics controlling reaeration. Other targets must therefore be considered.

This TMDL also provides for assessment endpoints to be more than simply numeric measures of in-stream DO and NH3-N. It will also include an assessment of the biological integrity of the system as measured by a macroinvertebrate Biological Index (BI) score, calculated in accordance with Missouri's standard procedures (10 CSR 20-7.031 (4)(Q)), which demonstrates fully supporting aquatic life uses of the stream.

This TMDL will be implemented in multiple phases. Phase one will include WLAs for ammonia and BOD_5 for the OSLS as described as an alternative in the original TMDL under *Implementation*, page 9. That WLA represents limits achievable by a modern mechanical plant using activated sludge processes and is a reduction from the current level of 45 mg/L of BOD_5 to 10 mg/L.

The stream response as measured by DO, nutrients, and the BI score will guide the phase two target nutrient loads and stream restoration practices which will achieve the state water quality standards if phase one monitoring and assessment indicate impairment after the OSLS upgrade. If the facility upgrade totally corrects the DO and aquatic life impairment, then phase two would consist of monitoring and evaluation. However, it after the upgrade, the stream remains impaired, additional watershed and stream restoration measures will be implemented. A watershed assessment would be performed to determine phase two implementation of non-point source control actions necessary to ultimately achieve the WQS. The watershed assessment would inventory potential nutrient sources, identify upland measures which would improve the water quality, identify stream riparian measures, and provide the basis for seeking funding to implement best management practices.

Summary of Numeric Instream Targets:

Table 1 summarizes the instream BI target and the numeric criteria from the Missouri Water Quality Standards for the two TMDLs on Davis Creek. A pH of 7.8 su and temperatures of either 26^{o}C for summer or 6^{o}C for winter were chosen to reflect typical conditions for this watershed.

Table 1: Instream Targets for Odessa Southeast Lagoon System

Dissolved Oxygen(mg/l) Criteria	*5.0*
*Biological Index established in accordance with Missouri's standard procedure** *Fall* *Spring*	 ≤ 7.33 (0-10 scale) ≤ 7.16 (0-10 scale)
Ammonia (mg/L), May-October (pH 7.8, Temperature 26° C, Limited Warm Water Fishery Chronic Criteria)	*2.0*
Ammonia (mg/L), November-April (pH 7.8, Temperature 6° C, Limited Warm Water Fishery Chronic Criteria)	*3.3*
Ammonia (mg/L), May-October (pH 7.8, Temperature 26° C, Limited Warm Water Fishery Acute Criteria)	*22.4*
Ammonia (mg/L), November-April (pH 7.8, Temperature 6° C, Limited Warm Water Fishery Acute Criteria)	*26.4*

*The target is the 25th percentile of reference condition from proposed biological criteria for glide/pool warm water streams within the Plains/Missouri tributaries between the Blue and Lamine Rivers Ecological Drainage Unit. Sampling occurs in Fall and Spring, and that is why this TMDL has targets during those seasons.

2. Calculation of Load Capacity

Load capacity is defined as the maximum pollutant load that will still attain water quality standards. For this stream, modeling results show that in addition to restricting loads from the plant, reduction in nutrient load and physical improvements are needed to achieve the in-stream DO standards. For the DO capacity, the target capacity was set based on an aggressive BOD_5 limit for an upgraded facility anticipating reopener clauses in the permit and improvements to the stream ecology. These improvements could be achieved by such actions as riparian improvement, land application of sludge in an environmentally sound manner subject to state and federal regulation during summer months, or upland reductions in nutrients. The extent of these measures can only be defined after a major upgrade to the facility has occurred and the model recalibrated to more accurately reflect the attained in-stream water quality. Ammonia limits achieve both chronic and acute in-stream water quality standards. For nutrients, the target is set to achieve an in-stream biological index score of: Fall -- ≤ 7.33 and Spring -- ≤ 7.16. Because the nutrients are also a function of the results of the upgrade to the WWTP, targets for reductions in either nitrogen or phosphorus will be set in Phase Two of the TMDL. For Phase One of this TMDL the Load Capacity was calculated by this formula:

Permit limit average daily load =(Design stream flow in cfs) times (in-stream pollutant concentration in mg/L) times (the constant 5.395 to convert to pounds/day.)

Average Monthly BOD_5 Phase One

1.55 cfs*10 mg/L*5.395= 84 lb/day

Average Monthly Ammonia Phase One

Summer:
2 mg/L*1.55 cfs*5.395=17 lb/day

Winter:
3.3 mg/L*1.55 cfs*5.395=28 lb/day

3. Load Allocation (Non-point Source Load)

The LA for ammonia is set at zero. For Phase One of the TMDL the LA for BOD_5 (DO) is set at improving the contribution to low DO levels from non-point source and riparian effects particularly during the critical summer low flow period. The LA is anticipated to be adjusted after the WWTP is upgraded based on future analysis and modeling.

Non-point source loads are those other than point source loads. Phase two of this TMDL will address stream response as measured by DO, nutrients, and the BI score, and will include target nutrient loads and stream restoration practices which will achieve the state water quality standards if phase one monitoring and assessment indicate impairment after the OSLS upgrade.

Evidence of livestock impacts in the creek was noted at Station #4. While there is only observational data, non-point source loads due to livestock impacts were estimated using information from the Missouri Agricultural Statistics Service Web Site. From the Web Site the total amount of cattle for the county was found. The drainage area for Davis Creek was delineated from United States Geological Survey topographical maps. The Davis Creek watershed above the impaired segment was estimated to be 2% of the county. Two percent of the total number of cattle found in the county is approximately 1000 cattle; this figure was confirmed by the Lafayette County Natural Resources Conservation Service personnel as being realistic. Since this is a phased TMDL, further study will determine what non-point source impacts from livestock exist.

4. Waste Load Allocation (Point Source Loads)

The Odessa Southeast Lagoon is the only point source load discharging to or impacting the impaired segment of Davis Creek. For ammonia, the permit will require meeting in-stream criteria concentrations at the discharge point; no allowance is given for mixing.

Summary of Loads

The load allocations for these TMDLs are summarized in the table below:

Loads to Davis Creek near Odessa, Mo. (pounds/day -- based on 30 day averages)

		Point Load (WLA)	Non-point Load (LA)	Margin of Safety (MOS)	Load Capacity
BOD_5		84	TBD*	Implicit	TBD*
Ammonia	Summer	17	0	Implicit	17
	Winter	28	0	Implicit	28

* TBD in Phase 2 of the TMDL based on a calibrated model for the upgraded plant, additional sampling of the stream, and an assessment of the cause of the depressed DO if it still is a problem after the plant upgrade.

5. Margin of Safety

An implicit margin of safety for this TMDL is based on the conservative assumption that multiple endpoints and subsequent monitoring is planned to confirm not only that the numeric standards for the stream are met, but the ecological system is fully supported as demonstrated by the macroinvertebrate population.

6. Seasonal Variation

Seasonal variation was simulated in the QUAL2E model via the use of lower water temperatures, lower ammonia and CBOD decay coefficients and adjustments to seasonal low flow values. Seasonal limits for ammonia are necessary because decay of these substances is biologically mediated and varies with water temperature and because dissolved oxygen gas saturation varies with water temperature.

7. Monitoring Plan For TMDLs Developed Under the Phased Approach

Permit requirements will include sampling the effluent weekly for BOD_5, pH, temperature and NH3-N. Phase One Ambient monitoring upstream and downstream of the outfall will collect nitrogen, phosphorus, and dissolved oxygen samples and other information necessary to calibrate the QUAL2E model and to assess nutrient loads from the watershed. Biological monitoring in accordance with Missouri's Standard Operating

Procedure (SOP) will be conducted after the plant upgrade to determine compliance with the targeted BI scores in this TMDL.

8. Implementation Plans

An implementation plan to revise the OSLS NPDES permit, if necessary, will include a permit re-opener clause. The OSLS will have three years to comply with the new operating permit revisions. Monitoring will be done on a regular basis to assure compliance with Missouri Water Quality Standards. These three TMDLs will be incorporated into Missouri's Water Quality Management Plan.

Since this is a phased TMDL, more water quality data will be gathered and a suitable model developed that more accurately account for both point and non-point source pollution.

Another option for the permit could be a no-discharge system during critical summer months. Land application of sludge conforming to state and federal regulations is another alternative to consider.

Riparian improvements may be viable opportunities to improve DO and aquatic community. Surveyors in the past have mentioned the deterioration of the riparian corridor. In some reaches, the surveyors noted that the stream was channelized and tree canopy was reduced or lacking. This channelization and reduced tree canopy can produce lowered velocity and unshaded pools. Warmer temperatures and higher algal production are created which result in lower dissolved oxygen and stress on fish and macroinvertebrates. Once Odessa's new wastewater treatment plant is online (Phase 1), improvements in Davis Creek can be measured to determine what role nonpoint contributions make to the lowered DO problem and a nonpoint allocation made (Phase 2). Problem areas will be identified and local input will be sought regarding implementation.

Local involvement is vital to the success of any TMDL implementation plan. The Lafayette County citizens have written two watershed management plans in the past: the Higginsville Lake Watershed Management Plan and the Concordia-Edwin A. Pape Lake Watershed Management Plan. Both plans were concerned with pesticides and to a lesser degree sediment and nutrients affecting their water supply lakes. The implementation of these plans resulted in the successful reduction of the herbicide atrazine found in these two water supply lakes. Expertise gained through these efforts will be helpful in writing an implementation plan to address nonpoint sources nutrients.

9. Reasonable Assurances

In developing waste load allocations for the permitted facilities, assumptions were made which depend on reductions in the load allocation from non-point sources. To ensure water quality standards are met, there must be reasonable assurance that non-point sources contributing to the water quality problems in Davis Creek will be addressed. If after the plant upgrade, the stream's water quality is not meeting the standards, the

permitee will take additional measures, such as land application of sludge or riparian improvement to insure water quality standards are met. In case the point source improvements do not fully address the impairment, additional assurance will be provided by a water quality project. State or local entities will seek funding for this project through EPA Section 319 non-point source grant funds or other funding mechanisms. Once the watershed assessment has identified actions that would reduce the non-point source loading, additional funding will be sought from a variety of funding sources to implement those practices. For example, EQIP, 319 funds, Special Area Land Treatment (SALT) funding, any city funding could be sought. Due to the uncertainty of the availability of grants, a variety of funding options need to be explored. The NPDES permit could be reopened following the assessment and subsequent implementation of non-point source control measures. Monitoring and assessment of water quality in response to the implementation of both point and non-point measures will lead decisions on additional actions necessary to ensure attainment of water quality standards. Local watershed groups would be expected to play a major part in this adaptive management of the watershed.

The Department of Natural Resources has the delegated authority to write and enforce NPDES permits. Inclusion of effluent limits, determined from the allocations and established in this TMDL, into an NPDES permit should provide reasonable assurance that instream water quality standards will be met. An agreement between MDNR and the City, separate from the NPDES permitting process, will define the actions the City should pursue if water quality standards are not achieved solely by the treatment plant upgrade. These activities include land acquisition for a retention basin or land application of effluent under certain adverse conditions. The City will also actively pursue education of the public regarding watershed issues and Best Management Practices (BMPs). The permittee, however, will only be accountable for improvements on City owned property should alternate disposal, riparian corridor improvements or other water quality management practices are deemed necessary.

10. Public Participation

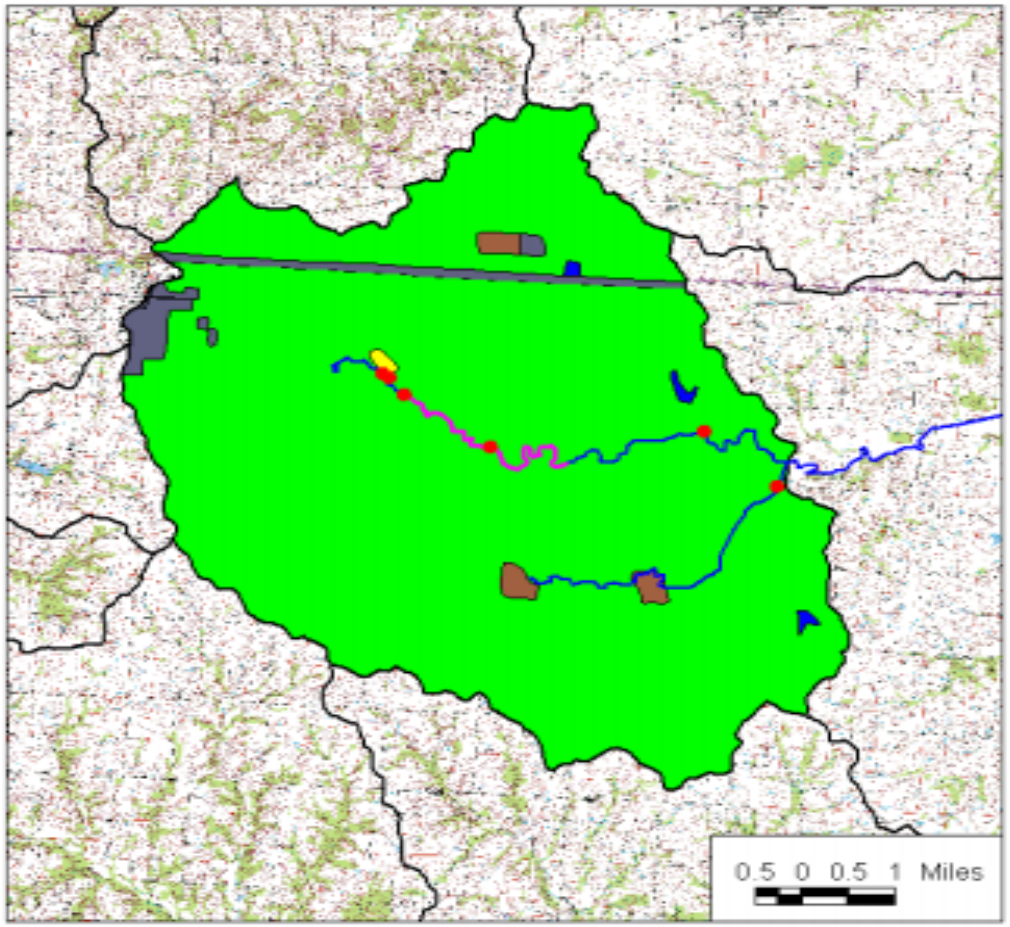
This water quality limited segment is included on the approved 1998 303(d) list for Missouri and a Total Maximum Daily Load document was approved by the EPA January 31, 2001. New monitoring data received after that date showed that nonpoint source pollution from agricultural sources were a problem contributing to the impairment that had not been taken into account in the original document. Consequently, Davis Creek was put on the proposed 2002 303(d) impaired waters list for nutrients. MDNR decided to revise the Davis Creek TMDL to include nonpoint nutrient impacts to Davis Creek. A meeting with EPA staff included a discussion of the Davis Creek TMDL and possible directions to take in the revised document occurred February 13, 2003. The Davis Creek TMDL was placed on public notice from April 28 to May 28, 2003. Three comments were received and responses returned. Copies of the public notice, comments and MDNR's response to comments are on file with MDNR.

Prior to the original TMDL approved in 2001, six public meetings to allow input from the public on impaired waters were held between August 18 and September 22, 1999. No comments pertaining to Davis Creek were received during the public meetings. This first TMDL document was sent to EPA for examination and then the edited draft placed on public notice. A public notice period was held from December 8, 2000 to January 7, 2001. Groups receiving the public notice announcement included the Missouri Clean Water Commission, the affected facility, the Water Quality Coordinating Committee, the TMDL Advisory Committee, Stream Team volunteers in the watershed, and others that routinely receive the public notice of NPDES permits. Copies of the notice, the comments and MDNR's response to the comments are on file with MDNR.

11. Administrative Record and Supporting Documentation:

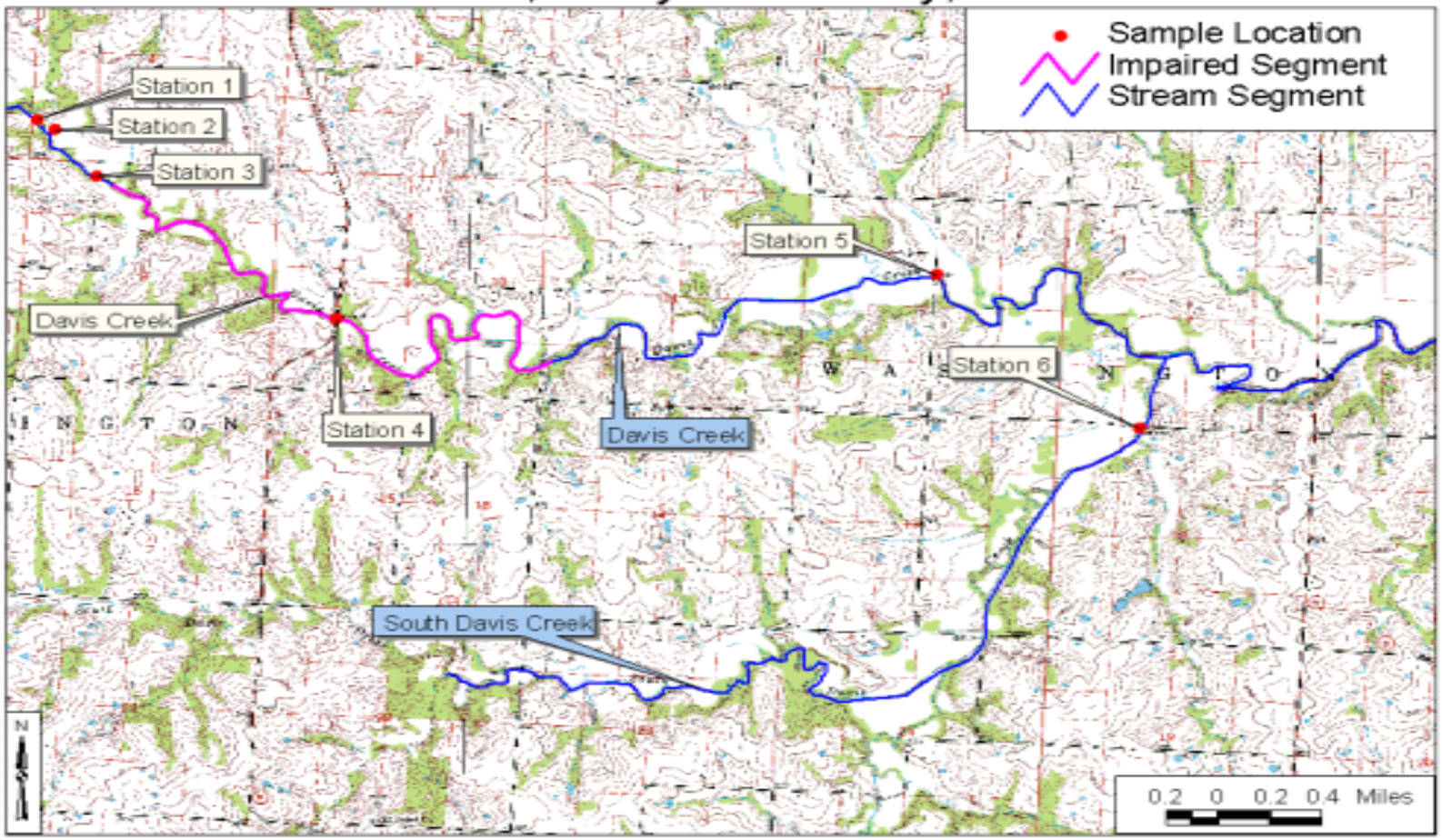
An administrative record on the Davis Creek TMDL has been assembled and is being kept on file with the Missouri Department of Natural Resources, including the following:
Topographical map of impaired segment with Sampling Station Number
Land use map
Input and output documents
Permit for OSLS
Public Notice document
Davis Creek Information sheet
Copies of comment letters and MDNR response letters
Data

Land Use Types for Davis Creek Watershed (10300104-060001)



Land Use Type		Area (acres)
Urban or Built-up Land		746
Residential	301	
Commercial and Services	50	
Trans, Comm, Util	395	
Agricultural Land		25701
Cropland and Pasture	25701	
Forest Land		237
Deciduous Forest Land	237	
Water		72
Reservoirs	72	
Barren Land		38
Transitional Areas	38	

Map of Sample Locations and Impaired Stream Segment
Davis Creek, Lafayette County, Missouri



DAVIS CREEK DATA

DATE	STATION	TIME	FLOW	WATER TEMP	DO	pH	NO3	NH4	CBOD
7/16/1997	1.00	546		24	4.00	8.00	0.06	0.07	<4
7/16/1997	1.00	1232		26	5.00	8.00	<0.04	0.06	<2
7/16/1997	2.00	530		28	5.00	9.00			
7/16/1997	2.00	1210		29	6.00	6.00	<0.04	0.04	17
7/16/1997	3.00	614		23	0.00	8.00	0.16	0.54	16
7/16/1997	3.00	1306		29	5.00	8.00	0.29	0.49	9
7/16/1997	4.00	645		23	2.00	7.00	0.31	1.22	<4
7/16/1997	4.00	1320		29	6.00	8.00	0.32	1.11	<4
7/16/1997	5.00	555		25	5.00	8.00	0.05	0.04	<2
7/16/1997	5.00	1240		30	9.00	8.00	0.04	0.02	<4
7/16/1997	6.00	525		24	5.00	8.00	<0.04	0.02	<2
7/16/1997	6.00	1215		26	6.00	8.00	<0.04	0.01	<2
7/17/1997	1.00	544		25	4.00	8.00	0.05	0.08	<4
7/17/1997	1.00	1223		27	5.00	8.00	<0.04	0.08	<2
7/17/1997	2.00	530		28	5.00	9.00			
7/17/1997	2.00	1205		30	8.00	10.00	<0.04	0.03	17
7/17/1997	3.00	607		24	0.00	8.00	0.19	0.86	12
7/17/1997	3.00	1246		29	4.00	8.00	0.24	0.66	9
7/17/1997	4.00	625		24	0.00	7.00	0.40	1.02	<4
7/17/1997	4.00	1320		31	7.00	8.00	0.39	0.86	<4
7/17/1997	5.00	550		25	5.00	8.00	<0.04	0.05	<4
7/17/1997	5.00	1250		32	9.00	8.00	<0.04	0.04	<2
7/17/1997	6.00	520		25	5.00	7.00	<0.04	0.03	<2
7/17/1997	6.00	1225		28	6.00	9.00	<0.04	<0.01	<2
7/8/1998	1.00	547	0.02	25	4.00	8.00	0.46	0.81	4
7/8/1998	1.00	555	0.02	26	4.00	8.00	0.20	0.07	4
7/8/1998	1.00	1330	0.02	31	10.00	9.00	0.27	0.01	4
7/8/1998	2.00	540	0.40						
7/8/1998	2.00	1310	0.40	33	9.00	9.00	0.12	0.39	21
7/8/1998	3.00	610	0.84	26	0.00	8.00	0.13	1.42	21
7/8/1998	3.00	1255	0.84	30	4.00	8.00	0.19	1.86	14
7/8/1998	4.00	625	1.48	26	2.00	7.00	0.38	1.63	4

7/8/1998	4.00	1335	1.48	30	5.00	8.00	0.34	1.7	5
7/8/1998	5.00	555	0.91	26	5.00	8.00	1.08	0.05	4
7/8/1998	5.00	1310	0.91	31	11.00	8.00	0.96	0.02	4
7/8/1998	6.00	525	0.63	27	8.00	7.00	0.58	0.01	2
7/8/1998	6.00	1245	0.63	28	10.00	8.00	0.46	0.01	2
7/9/1998	1.00	1310	0.02	28	8.00	8.00	0.16	0.01	4
7/9/1998	2.00	607	0.40	32	7.00	9.00	0.10	0.595	21.5
7/9/1998	2.00	1245	0.40	30	5.00	8.00	0.07	0.8	22
7/9/1998	3.00	530	0.84	27	0.00	8.00	0.11	1.9	23
7/9/1998	3.00	1325	0.84	30	3.00	8.00	0.17	2.15	14
7/9/1998	4.00	620	1.48	26	2.00	8.00	0.27	1.92	4
7/9/1998	4.00	1340	1.48	28	4.00	8.00	0.24	2.02	6
7/9/1998	5.00	555	0.91	26	5.00	8.00	0.86	0.04	4
7/9/1998	5.00	1315	0.91	29	12.00	8.00	0.80	0.03	2
7/9/1998	6.00	530	0.63	26	9.00	8.00	0.35	0.01	2
7/9/1998	6.00	1250	0.63	28	11.00	7.00	0.27	0.01	3
3/3/2000	1.00	847	0.40	6	10.00	8.00	<0.05	<0.05	<2
3/3/2000	1.00	1145	0.40	6	12.00	8.00	<0.05	<0.05	<2
3/3/2000	2.00	840	0.02	6	8.00	7.00	0.28	<0.05	<2
3/3/2000	2.00	1150		6	11.00	7.00	0.23	0.38	2
3/3/2000	3.00	810	0.45	6	10.00	8.00	0.10	<0.05	<2
3/3/2000	3.00	1205		6	13.00	8.00	0.07	<0.05	<2
3/3/2000	4.00	750		7	9.00	8.00	0.07	<0.05	<2
3/3/2000	4.00	1215		7	11.00	8.00	0.07	<0.05	<2
3/3/2000	5.00	730	0.30	6	10.00	8.00	0.09	<0.05	<2
3/3/2000	5.00	1230		7	14.00	9.00	0.08	<0.05	<2
3/3/2000	6.00	710		7	10.00	7.00	0.56	<0.05	2
3/3/2000	6.00	1235		7	12.00	8.00	0.49	<0.05	2

Site Name	Yr	Mo	Dy	Time	Flow	C	DO	pH	SC	KJN	NH3N	NO3N	TP	CBOD	TSS
Davis Cr. 0.3 mi.bl. Odessa SE Lgn	1998	7	8			26	0.5	7.59	525		1.42	0.13		21	
Davis Cr. 0.3 mi.bl. Odessa SE Lgn	1998	7	8			30	4.3	7.91	527		1.86	0.19		14	
Davis Cr. 1.7 mi.bl. Odessa SE Lgn	1998	7	8			30	4.6	7.73	526		1.7	0.34		5	
Davis Cr. 1.7 mi.bl. Odessa SE Lgn	1998	7	8			26	1.8	7.34	525		1.63	0.38		1.99	
Davis Cr. 5.2 mi.bl. Odessa SE Lgn.	1998	7	8			31	10.9	7.95	374		0.02	0.96		1.99	
Davis Cr. 5.2 mi.bl. Odessa SE Lgn.	1998	7	8			26	5.4	7.47	369		0.05	1.08		1.99	
Davis Cr. 50 yds.ab. Odessa SE Lgn.	1998	7	8		0	25	4	7.75	427		0.81	0.46		1.99	
Davis Cr. 50 yds.ab. Odessa SE Lgn.	1998	7	8		0	31	9.9	8.6	407		0.00499	0.27		1.99	
Odessa SE Lgn. Effluent Trib.	1998	7	8			30	5.3	8.1	520						
Odessa SE Lgn. Effluent Trib.	1998	7	8			33	9	9.2	507		0.39	0.12		21	
South Davis Cr. Nr mouth	1998	7	8		0.08	28	10.2	7.75	355		0.00499	0.46		0.99	
South Davis Cr. Nr mouth	1998	7	8		0.08	27	8.2	7.31	361		0.00499	0.58		0.99	
Davis Cr. 0.3 mi.bl. Odessa SE Lgn	1998	7	9			30	3.1	7.9	544		2.15	0.17		14	
Davis Cr. 0.3 mi.bl. Odessa SE Lgn	1998	7	9			27	0.2	7.58	537		1.9	0.11		23	
Davis Cr. 1.7 mi.bl. Odessa SE Lgn	1998	7	9			26	1.5	7.75	536		1.92	0.27		1.99	
Davis Cr. 1.7 mi.bl. Odessa SE Lgn	1998	7	9			28	4.4	7.48	543		2.02	0.24		6	
Davis Cr. 5.2 mi.bl. Odessa SE Lgn.	1998	7	9			29	11.8	7.7	403		0.03	0.8		0.99	
Davis Cr. 5.2 mi.bl. Odessa SE Lgn.	1998	7	9			26	5.4	7.92	398		0.04	0.86		1.99	
Davis Cr. 50 yds.ab. Odessa SE Lgn.	1998	7	9			28	7.7	8.13	447		0.00499	0.16		1.99	
Davis Cr. 50 yds.ab. Odessa SE Lgn.	1998	7	9			26	4	7.77	437		0.07	0.2		1.99	
Odessa SE Lgn. Effluent Trib.	1998	7	9			30	5.2	8.31	525						
Odessa SE Lgn. Effluent Trib.	1998	7	9			30	4.8	8.18	529		0.8	0.07		22	
South Davis Cr. Nr mouth	1998	7	9			28	11.1	7.4	347		0.01	0.27		3	
South Davis Cr. Nr mouth	1998	7	9			26	9.3	7.95	355		0.00499	0.35		0.99	
Davis Cr. 0.3 mi.bl. Odessa SE Lgn	2000	3	3	1205		6.3	12.6	8	732	1	0.02499	0.07	0.07	0.99	
Davis Cr. 0.3 mi.bl. Odessa SE Lgn	2000	3	3	810	0.45	6	9.8	7.7	728	1	0.02499	0.1	0.08	0.99	

Site Name	Yr	Mo	Dy	Time	Flow	C	DO	pH	SC	KJN	NH3N	NO3N	TP	CBOD	TSS
Davis Cr. 1.7 mi.bl. Odessa SE Lgn	2000	3	3	1215		7	11.4	8.1	651	0.499	0.02499	0.07	0.09	0.99	
Davis Cr. 1.7 mi.bl. Odessa SE Lgn	2000	3	3	750		7	9.4	7.9	656	1	0.02499	0.07	0.11	0.99	
Davis Cr. 5.2 mi.bl. Odessa SE Lgn.	2000	3	3	1230		7	14	8.7	529	0.499	0.02499	0.08	0.1	0.99	
Davis Cr. 5.2 mi.bl. Odessa SE Lgn.	2000	3	3	730	0.3	6.4	9.7	8	539	0.499	0.02499	0.09	0.13	0.99	
Davis Cr. 50 yds.ab. Odessa SE Lgn.	2000	3	3	1145	0.4	6.4	11.6	8	722	1	0.02499	0.02499	0.06	0.99	
Davis Cr. 50 yds.ab. Odessa SE Lgn.	2000	3	3	847	0.4	6	10.4	7.8	726	0.499	0.02499	0.02499	0.04	0.99	
Odessa SE Lgn. Effluent Trib.	2000	3	3			6	8.5	7	1230	1	0.02499	0.28	0.35	0.99	
Odessa SE Lgn. Effluent Trib.	2000	3	3	1150	0.05	6.5	10.8	7.3	805	1	0.02499	0.23	0.38	2	
South Davis Cr. Nr mouth	2000	3	3	1235		7.3	12.4	8.5	422	1	0.02499	0.49	0.08	2	
South Davis Cr. Nr mouth	2000	3	3	710		7.2	9.9	8.2	412	2	0.02499	0.56	0.12	2	
Davis Cr. 0.3 mi.bl. Odessa SE Lgn	2002	8	14	1445	0.67	25	4.4	7.8	619	5.83	2.42	0.26	1.77	10.2	14
Davis Cr. 0.3 mi.bl. Odessa SE Lgn	2002	8	14	632		20	4.6	7.8	671	6.79	2.75	0.02499	2.07	12.5	161
Davis Cr. 1.7 mi.bl. Odessa SE Lgn	2002	8	14	652		21	4.9	7.7	647	2.78	0.35	0.3	0.55	2.8	36
Davis Cr. 1.7 mi.bl. Odessa SE Lgn	2002	8	14	1416	3.2	25.5	6.1	8	654	2.47	0.27	0.31	0.52	4.7	24
Davis Cr. 3.3 mi.bl. Odessa SE Lgn.	2002	8	14	710	2.98	21	4.35	7.6	556	2.01	0.22	0.35	0.25	0.99	55
Davis Cr. 3.3 mi.bl. Odessa SE Lgn.	2002	8	14	1358		23	5	7.7	561	2	0.11	0.37	0.23	2.5	28
Davis Cr. 5.2 mi.bl. Odessa SE Lgn.	2002	8	14	727	1.05	19	6.2	7.9	484	1.11	0.02499	0.02499	0.1	0.99	2.499
Davis Cr. 5.2 mi.bl. Odessa SE Lgn.	2002	8	14	1337		30	8.4	8.9	474	1.15	0.02499	0.02499	0.11	0.99	2.499
Davis Cr. 50 yds.ab. Odessa SE Lgn.	2002	8	14	603		21	5.4	7.7	425	0.91	0.02499	0.07	0.12	0.99	16
Davis Cr. 50 yds.ab. Odessa SE Lgn.	2002	8	14	1508	1.54	25	5.4	7.8	436	0.66	0.02499	0.07	0.1	0.99	11
Odessa SE Lgn. Effluent Trib.	2002	8	14	616	0.44	24	6.9	8.4	659	7.57	1.31	0.02499	2.16	18.9	33
Odessa SE Lgn. Effluent Trib.	2002	8	14	1501		27	7	8.5	658	7.65	1.14	0.06	2.2	13.7	32
South Davis Cr. Nr mouth	2002	8	14	745	1.14	18.5	5.8	8.1	319	0.66	0.02499	0.02499	0.08	2.3	28
South Davis Cr. Nr mouth	2002	8	14	1324		22.5	7.2	8.7	313	0.84	0.02499	0.02499	0.08	0.99	13
Davis Cr. 0.3 mi.bl. Odessa SE Lgn	2002	9	11	700	0.2	21	0.499	8.2	729	6.27	1.49	0.02499	2.48	8.9	30
Davis Cr. 0.3 mi.bl. Odessa SE Lgn	2002	9	11	1339		23	4	8.1	702	6.59	1.23	0.1	2.51	18.6	88

Site Name	Yr	Mo	Dy	Time	Flow	C	DO	pH	SC	KJN	NH3N	NO3N	TP	CBOD	TSS
Davis Cr. 1.7 mi.bl. Odessa SE Lgn	2002	9	11	716		22	1.6	8	727	2.62	0.36	0.22	0.91	3	90
Davis Cr. 1.7 mi.bl. Odessa SE Lgn	2002	9	11	1312	0.16	24	4.2	7.8	718	2.73	0.28	0.23	0.91	3	14
Davis Cr. 3.3 mi.bl. Odessa SE Lgn.	2002	9	11	1247		22	2.9	7.7	691	2.19	0.18	0.31	0.24	0.99	11
Davis Cr. 3.3 mi.bl. Odessa SE Lgn.	2002	9	11	728	0.01	21	1.3	7.9	706	2.31	0.2	0.3	0.26	0.99	18
Davis Cr. 5.2 mi.bl. Odessa SE Lgn.	2002	9	11	1231	0.02	25	5.9	8.4	336	0.78	0.02499	0.02499	0.13	0.99	54
Davis Cr. 5.2 mi.bl. Odessa SE Lgn.	2002	9	11	746		20	5.4	8.9	349	0.62	0.02499	0.02499	0.11	0.99	22
Davis Cr. 50 yds.ab. Odessa SE Lgn.	2002	9	11	1359		24	5.8	8	391	0.68	0.02499	0.02499	0.11	3	14
Davis Cr. 50 yds.ab. Odessa SE Lgn.	2002	9	11	627	0.17	20	3.1	7.9	393	0.98	0.02499	0.02499	0.13	2	50
Odessa SE Lgn. Effluent Trib.	2002	9	11	636	0.17	25	4.6	8.8	744	7.81	0.09	0.05	2.86	15.5	71
Odessa SE Lgn. Effluent Trib.	2002	9	11	1351		27	5.4	8.9	672	7.18	0.05	0.02499	2.78	19.6	57
South Davis Cr. Nr mouth	2002	9	11	759		19	2	8.1	395	0.86	0.02499	0.02499	0.13	5	39
South Davis Cr. Nr mouth	2002	9	11	1214		23	4.2	8.3	424	1.11	0.02499	0.02499	0.14	8	25

Davis Creek Macroinvertebrate Data

Sample No.	Water-body	Sea-son	Year	TRw Chiro	EPT TAXA	Biw Chiro	Siw Chiro	Biw Chiro	SIwChiro	TR _Q	TR_ B	Score_ TRwCh
984847	Davis Ck	S	1998	70	12	7.427963	2.530365	7.427963	2.530365	71	36	3
984848	Davis Ck	S	1998	48	5	8.105818	2.916503	8.105818	2.916503	50	25	3
988957	Davis Ck	F	1998	69	10	7.116121	2.486257	7.116121	2.486257	68	34	5
988958	Davis Ck	F	1998	55	4	7.834953	3.087497	7.834953	3.087497	58	29	3

EPT _Q	EPT _B	Score_E PTTaxa	BI_Q	Score_B IwCh	SI_Q	SI_B	Score_SI wCh	Total_ Score	NVAL	CriteriaCat
13	6	3	6.448843	3	2.800808	1.400404	3	12	13	RP_S_W_PMOBL
8	4	3	7.156479	3	2.29318	1.14659	5	14	9	GP_S_W_PMOBL
13	6	3	7.053335	3	3.077887	1.538944	3	14	11	RP_F_W_PMOBL
6	3	3	7.332527	3	2.88778	1.44389	5	14	8	GP_F_W_PMOBL